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OIL ENGINE PROBLEMS AND ACHIEVEMENTS

AN OIL MAN'S POINT OF VIEW

By J. J. BROEZE* (Member)

Perhaps, to future generations, 20th century engineers will appear as men wrestling doggedly with seemingly impossible pieces of machinery in order to compel them to relatively simple tasks. If so, there will surely be amazement at, if not admiration for those by that time held responsible for the oil engine. Even now, it is interesting to consider how people must have clung to certain ideas throughout the long years between the empirical pioneering of Akroyd Stuart, and the contorted applied thermodynamics of Dr Diesel, and the present day, when we meet the oil engine in various functions as a respected—if not always beloved—and faithful servant. So strong has been the grip of the idea of what is the most efficient heat engine on the minds of those many designers and operators, that for long periods they have continued to hold them in the face of tremendous odds and far from favourable tests. Güldner, a German manufacturer of gas and oil engines and author of a once-famous, voluminous textbook on the subject, rightly spoke about the "Diesel-Dusel," or diesel daydream, and advocated greater attention to the more honest and meritorious subject of the gas engine. Yet, now, although taking second place to the petrol engine, the oil engine has risen to greatness, whereas the gas engine, interesting though it is, has faded into relative insignificance. The cause is, of course, the enormous growth of demand for mobile power, for transport as well as

*Director of Delft Laboratory of Royal Dutch/Shell Group; Associated Professor at Delft Technical University.

for agriculture and for temporary duties such as contractors' work; and, as usual in these matters, demand and fulfilment stimulate each other so that, for instance, modern contractors' methods are unthinkable without the high-speed oil engine.

The arduous road over which the oil engine has advanced shows, in review, hazards of many kinds. The purely mechanical problems of strength under combined mechanical and thermal load and of stiffness under variable frequency pulses are augmented by the fluid dynamics problems of breathing, fuel injection and mixing, and by a very complex chemistry. In fact, it is the very late growth of engine chemistry that has held up oil engine development as much as the much more obvious lack of manufacturing skill in making delicate parts to close tolerances. On the other hand, it may be expected that deeper understanding of it may bring about great further development and changes in oil engine technique.

Engine chemistry is the result of teamwork between engineers and chemists that has prevailed since, in about 1930, the oil industry started in several places to study what happened to its products in the customers' hands. Previous chemical views and theories on fuel and lubricant behaviour were, to our present way of thinking, somewhat academic, and it was some time before the engineers, delving deeper than before, could lay their problems before the chemists in such a way that the latter could really come to grips with them. In the following pages it is hoped to record some observations on the present status of the oil engine, taking into consideration its principal applications, its typical problems, and its future possibilities as seen by the author.

The main types to be discussed are the marine engine and the high-speed road and rail transport engine. For marine propulsion in seagoing ships, the low-speed direct-coupled engine running at speeds of 100-150 r.p.m. in big powers (up to 10,000 h.p.) has reigned supreme ever since this special modification was adopted some forty years ago. It is built in almost every conceivable form: single and double-acting opposed piston, two or four-stroke. The preference is usually given on account of dimensional advantages if not on grounds of good relations between shipowner, yard and engine builder, so that one might wonder what advantage there might be in one type rather than another. Recently, it would seem as if the single-acting two-stroke engine were becoming the most popular; but fashion may change again. Specific power has doubled in twenty years. A few abortive attempts have been made at big diesel-electric installations and, in a few other cases geared engines are used which then run at about double propeller-shaft speed. Such engines have the dimensional advantage of low height—very valuable in passenger ships—and may have the operational advantage of allowing overhauls to be made without losing time at sea if a surplus of power is provided for.

This last point is receiving more and more attention. For that matter, in all types of power plant maximum availability is required for exploiting not only the capital tied up in the power plant but also the usually much bigger amount invested in the installation which it serves. Let us consider what this amounts to in general terms.

The two principal lines of approach to the availability problem are reliability and subdivision. That is to say, if one wants to provide for all contingencies, for a certain task three engines should be installed: one to do the work, one to switch to if there is a failure in number one, and a third to switch to if at that moment number two happens to be in overhaul. Leaving out the third engine would not greatly decrease the availability, especially if the installation has rest periods which may be used for

inspection and overhaul: engines may be designed and built in such a way that they contain a number of easily replaceable wearing parts (pistons, cylinder liners, valves), whereas the other parts, even the crankshaft and its bearings, may be made to last for extremely long periods without wear or breakage.

In transport, often only one engine is used for reasons of simplicity or efficiency. In such a case, reliability must be sought in design and rating so that all parts have a long life and are reliable during that life, and so that overhaul is possible during a planned pause in operating. In the case of small units, such as aero-engines and automobile engines, a solution has been found by simply replacing the engine. In single-engined ships, everything must be done to ensure that between the times in port and the prescribed surveys nothing goes wrong with the engine. This leads to a certain conservatism in design and rating. An engine may be operated even without one of its pistons if need be, so that with the most likely kinds of trouble a single-engined ship can at least get home. Thus two engines give no marked advantage except in the most unusual emergency.

Another degree of security is, however, obtained with a multiplicity of engines because, in theory at least, one may use only some 80 or 90 per cent of them and have several in spare if one of the operating units falls out. The main difficulties with this otherwise extremely attractive way of working are at present those of coupling all the units to one or two propeller shafts, and the fact that small engines use more and dearer fuel and more lubricating oil than big engines whilst costing somewhat more to keep in repair. A typical step in this direction is an installation like that of the *Willem Ruys*, with eight engines detachably coupled over reduction gearing to two shafts. Usually, on this ship, two engines are kept in reserve and may be serviced under way.

The main problems encountered in marine engines, particularly of the two-stroke type are, perhaps, cylinder and piston-ring wear when running at high output. To these are added isolated cases of corrosion of parts in the crankcases, due mostly to the combined presence of sulphuric acid from used cylinder oil, and salt from seawater or salty air. Much has been written of the cylinder and ring wear problem during the last ten or fifteen years. In the writer's experience, there is a distinct correlation between this wear and the sulphur content of the fuel, but this is certainly not the only cause of abnormal rates of wear. The basic difficulty may rather be sought in the two-stroke power cycle itself, in which the top piston ring has to carry with it a film of oil, enough to lubricate it throughout the critical reversal of movement at the top of the stroke. The oil left on the cylinder wall is subjected to heat and oxygen from the moment the piston starts to move down, and at high loads may disappear almost entirely, so that everything depends on what the top ring brings with it. This ring, however, stands under a pressure practically equal to the cylinder pressure and as it slows down on the upstroke, most of the oil is squeezed out from between cylinder and ring.

A type of wear that may be expected under such conditions is that called scuffing, which is actually due to local spot welding and subsequent disruption of these tiny welds. This type of wear completely destroys smooth, run-in surfaces, and aggravates corrosive action of sulphurous gases by the said surfaces and the wear debris. The often-practised chromium plating of affected parts is particularly effective under such conditions. Some aspects of the influence of fuel characteristics, other than sulphur content, on cylinder wear are by no means clear. Recently, new observations from practice have been put before the technical world.*). Some

Motor Ship*, Dec. 1949, **30 (359), 362-5.

of the influences suggested, such as the unfavourable influence of a high hydrogen content—corresponding to highly paraffinous types of hydrocarbons—would appear at first sight to be highly improbable; but verification of experiences by others and comparison with research results will be necessary. The four-stroke engine is much less vulnerable to this wear, as it has an idle stroke between each two firing strokes when some oil is redistributed. Moreover its thermal load is usually lower. It is for this reason that successful attempts to burn heavy fuels, which also have relatively high sulphur contents, have been made mostly on four-stroke engines.

However, it would seem that, given due attention to purification, a problem of some magnitude with highly viscous fuels which may contain emulsions or sludges, marine oil engines would be able to work with a very wide range of fuels. A clean, short, well cut-off period of fuel injection is essential, but this may be controlled entirely by design and maintained in practice (Fig. 1).

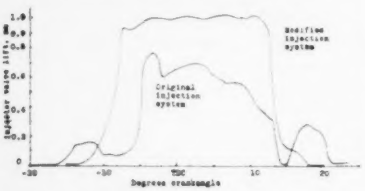

Fig. 1.

In particular, the oil engine is highly insensitive to the small amounts of organically bound ash in many residual fuels, a material which may be very troublesome in other applications, such as high temperature steam boilers and, particularly, gas turbines. This ash may become chemically active towards certain construction materials at high temperatures; in the oil engine it is possible to design so as to avoid these high temperatures. Hence, it would seem that the oil engine has considerable advantages by comparison with the steam turbine and the gas turbine. The steam turbine is less efficient, but has so far used a much cheaper fuel; the latter in the long run may be as efficient, but quite probably more dainty in its taste.

In the meantime, the last twenty years have witnessed practically the entire history of the high-speed oil engine. After the original astonishment that the complicated combustion process of the compression-ignition engine could be performed at high speeds of revolution, as was demonstrated in isolated cases around 1925, the engine industry started development in earnest after a German pioneer firm had made injection equipment available. As in the first decades of the classical oil engine, incredible ingenuity and tenacity had to be brought to bear on the very difficult problems encountered. Within some five years, the mechanical principles were mastered to the degree that reliable operation with acceptable purity of the exhaust gases became possible, even for city operation, as in the case of buses. Combustion knock was mostly very much in evidence, despite investigations by the oil industry which had already led to the proposal of ignition-quality rating methods and cetene (later: cetane) number, followed by the general introduction of relatively high cetane-number fuels for high-speed engines. Furthermore, somewhat stringent maintenance schemes had to be adopted, both for the injection equipment, which easily became deranged by wear and tear, and for the piston assembly which showed abnormal tendencies to ring sticking or ring groove packing. The latter troubles were seen by most as belonging to the oil engine: the unrefined fuel, the imperfect mixing of fuel and air, the high temperatures of the piston, the low temperatures of the piston, the high pressures and the excess of air all being taken separately or together as causes. It was found that highly refined or extracted lubricating

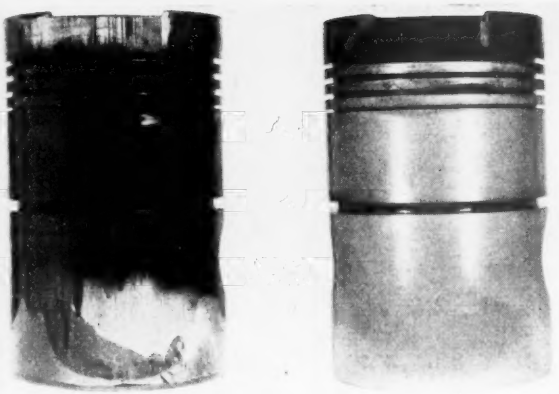

Fig. 2. Eloquent testimony of improved conditions brought about by additive oil.

oils, such as were introduced around 1935 as improved motor oils, brought no improvement in this situation. On the contrary, they made it worse in several cases. The following years brought gradual, sometimes very significant improvement in power, exhaust and combustion noise as the result of detail improvements but the piston assembly problems were only attacked in a significant way by the introduction in the United States, as a result of co-operation between the engine and oil industries, of special additives, first known mainly as anti-ring sticking dopes.

The last ten years, including the war, have seen the ending of the situation where the difficulty of piston assembly maintenance for high-speed oil engines acted as a brake on their further development. The additive-type lubricating oil for this class of engine will in due course be seen as the equivalent of high-octane petrol for spark-ignition engines in opening the door to higher performance in power and endurance; these achievements form a tremendous contribution by the oil industry to the technique of the internal combustion engine (Fig. 2).

It became evident during this last period that more than any of the factors mentioned, sulphur in the fuel was responsible not only for abnormal wear but also for most of the fouling typical of the high-speed oil engine. Notwithstanding efforts to reduce the sulphur content of heavy distillates, this still remains a commercial impossibility; and neither the shifting trend in refining nor the change in importance of certain crude oil types has done much to ease this situation. But, once the main cause has been found, work towards the undoing of its effects could proceed.

Thus, following the production of the standardized "Heavy Duty" or 2-104B lubricating oils during the war, later additive-type oils have been deliberately developed using fuels of appreciable sulphur content during the engine tests concerned. The importance of this factor was realized at an early date with the result that ten years of intensive development work on high-grade additives has taken place on the basis of fuels having a sulphur content of 1 per cent and over.

This has given rise to the conviction that the practical difficulties due to sulphur, to wit fouling and increased wear, may be solved in an economical fashion by these additives. We look nowadays with perfect confidence to overhaul periods of 5000 hours where before the use of additives this period was 500, and to rates of wear of as low as 0.2-thousandths of an inch per 1000

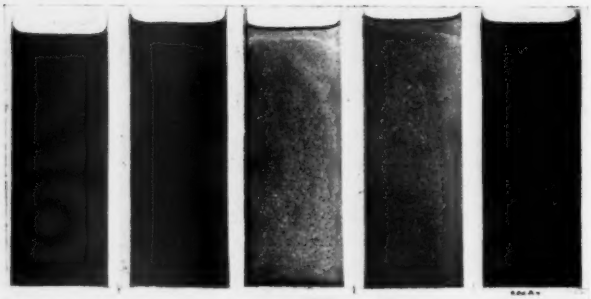

Fig. 3.

0 0.003 0.01 0.03 0.10

Percentage of Ca soap added.

A slightly oxidized oil as used in the above series shows peptizing properties (0%). A small amount of calcium soap addition produces flocculation (0.01%). On the addition of larger amounts peptization again ensues.

hours with fuels of over 1 per cent sulphur, where it used to be a thousandth or more.

Already, the first steps in additive development, leading to the "heavy-duty" oil, have aroused great enthusiasm amongst the users of such engines, who feel they will avoid much worry and high maintenance costs. Some designers are beginning to cash in, in the form of increased ratings, and in the United States oils are being developed to cope with this situation and that of increased sulphur content. We feel as confident now of coping with the designers' advances as we felt ten years ago with regard to 100-octane aviation petrol.

However, much has still to be learned as to the application of these oils. The active element has partly the function of peptizing oxidation products and other insolubles in order to bring about their removal with the lubricating oil stream upwards or downwards from the ring belt zone, the most dangerous area, and to prevent their settling. Partly also, it has the plain duty of fighting the action of acids by its alkalinity.

As to the former duty, as Van der Minne* has shown, oxidation resins—in themselves good peptizers—may be antagonistic to the effect of the additive (Fig. 3). His findings in this field have led to further investigations into the character of non-aqueous colloids, on which it is hoped that more may be published in due course. In view of this curious antagonism, a watch should be kept on too strong oxidation of the oil. This is of little consequence as long as there is adequate washing and interchange of oil with the big quantity of oil in the crankcase, which does not usually get very strongly oxidized. But it explains why these additives have not been as markedly successful in many cases in separate cylinder lubrication and particularly in two-stroke engines. Here there is need to keep the oil from the cylinder and its parts as much as possible and there is little washing action and little improvement to be expected from the improved oils. This fact may well turn the attention of designers once more away from the two-stroke to the highly supercharged four-stroke engine.

In the duty of combating acid conditions, the additive is gradually used up so that the more serious conditions are, the more frequently must the oil be changed, or the additive must be used in great concentrations; and the cost of the additive in the lubricant must be balanced against any price differentials of different grades of fuel.

It is difficult to foretell what influence these developments will have on the

* *Rec. Trav. Chim.* 1946, **65**, 549.

expansion of oil engine power. Certainly, the progress of the oil engine in the road vehicle field and the tractor field will be hastened by the lowering first of maintenance cost and subsequently of engine first-cost through the higher rating made possible. It may be predicted, however, that Ricardo's old and at that time premature project of the multi-engined ship* will soon become a technical possibility, if not with bus engines, then at least with quantity-produced standardized units small enough to be manhandled and taken out for maintenance and repair. The simple fact of having engines detached from the ship's structure would mean great advances in the prevention of vibration and crankcase corrosion, as increased temperatures might then be employed. Glass or silicone insulation on electric equipment and forced cooling, open up possibilities for much reduced weights and transmission costs, which would seem to be the main complication.

Altogether, the diesel engine is better qualified than ever to take its place in the power picture. Still at the top of the list for thermal efficiency, with large increases therein made possible by compounding, it now shows aptitude for increased flexibility in the choice of its fuel and for radically decreased maintenance costs. It lends itself well to standardization, with the consequent advantages of modern large-scale reproduction methods, so that its first cost will also drop both from this cause and from the increased ratings to be obtained.

* H. R. Ricardo, "High-Speed Diesel Engines for Marine Service," *Proc. Instn. Mech. Engrs*, 1933, **125**, 293.

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Kelloggram No. 4 (1950) describes the conversion of a surplus process unit into a modern lubricating oil plant. Publishers are The H. M. Kellogg Co., Jersey City, N.J., U.S.A.

INTERNATIONAL CHEMICAL MEETINGS IN THE U.S.A. IN 1951

The British National Committee for Chemistry of the Royal Society directs attention of British chemists to the following meetings:

September 3-7, New York. American Chemical Society; divisional meetings, etc.

September 8-9, New York. International Union of Pure and Applied Chemistry; meetings of commissions.

September 10-13, New York. International Congress of Pure and Applied Chemistry; sectional meetings, etc.

September 14-15, Washington, D.C. International Union and Jubilee of the Bureau of Standards, visits, banquet, and council meeting.

Attendance at the International Congress of Pure and Applied Chemistry is open to any chemists who wish to participate, and the 16 sections cover every aspect of modern chemistry.

Organizing secretary is Dr Harry L. Fisher, National Research Council, 2101 Constitution Avenue, Washington 25, D.C. and registration fee for membership of the Congress is $7.50 and combined fee for Congress and Jubilee is $13.00.

Enrolment forms are available from the Assistant Secretary of the Royal Society, Burlington House, London, W.1.

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STORAGE TANKS MOVED BY SEA

Four oil storage tanks, with a total capacity of more than 2,000,000 gallons, recently made a 75-mile sea trip across the Southern Kattegat, Denmark.

The tanks, belonging to A/S Dansk Shell, were towed one at a time by the tug *Svava* from Korsør to the ocean terminal at Frederica, which is currently undergoing extension. Time taken for each journey was 16-20 hours, including delays while awaiting favourable landing conditions.

NEW I.P.C. DIRECTOR

G. W. Dunkley, O.B.E., M.Inst.Pet., has been appointed an executive director of the Iraq Petroleum Company and Associated Companies with effect from January 1, 1951.

Educated at St. Albans School and at Pembroke College, Cambridge, Mr Dunkley entered the London Office of the Anglo-Persian Oil Company in 1914. He served in the Royal Marines during the first world war and was awarded the O.B.E. for services at the Admiralty. He rejoined the Anglo-Persian Oil Company in 1919 and in 1931 was seconded to the Iraq Petroleum Company as the Company's agent in Iraq, Palestine, Transjordan, Syria, and the Lebanon. In March 1935 he was appointed general manager in the Middle East, and was transferred to the London Office shortly before the outbreak of war.

In July 1940 the I.P.C. placed the services of Mr Dunkley at the disposal of the War Office, as a member of the Standing Committee on Army Administration under the Chairmanship of Sir James Grigg.

In January 1942 he was attached to the Minister of State as Petroleum Adviser in the Middle East, returning to the I.P.C. in January 1944. As a member of the management in London for the last seven years, Mr Dunkley has had a large share in the planning and construction of the 16-inch pipelines from Kirkuk to the Mediterranean and of the 30-inch line to Banias, on which construction has recently commenced.

International recognition of Mr Dunkley's services to the petroleum industry includes: Chevalier of the Legion of Honour, the Order of Ar Rafidain (Iraq), the Order of Istiklal (Jordan), and the Order of Merit of the Lebanese Republic.

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FESTIVAL OF BRITAIN VISITS TO FACTORIES

British manufacturers who are willing to receive visitors at their factories during the Festival of Britain, 1951, are invited to send particulars to the Council of Industrial Design, Tilbury House, Petty France, London, S.W.1. The Council will compile a list of such firms and arrange for it to be carried at all industrial information bureaux in the official Festival exhibitions. The list will be issued to visitors on presenting a trade or business card.

Manufacturers should indicate the goods they make, the approximate number of employees in the factory, the most convenient days and hours for receiving visitors and the person to whom visitors should apply in advance. Details of languages spoken by staff available as conductors will be welcome.

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CRUDE OIL COMPANY PRODUCTIONS

	Nov. 1950	*Dec.*
	Brl	
Kern Oil Co. Ltd.		
California	115,842	122,007
Trinidad	50,135	51,573
	165,977	173,580
British Controlled Oilfields Ltd.		
Venezuela (Western area)	11,941	11,830
Venezuela (Central area)	16,307	17,852
Ecuador	40,754	39,836
	69,002	69,518
Trinidad Petroleum Development Co. Ltd.	240,860	252,310

COUNCIL COMMENTARY

During the early part of the present session, two successive Council meetings finished at 4 to 4.30 p.m. because of the light Agenda. This left a somewhat awkward gap until tea at 5 p.m. and the accompanying pleasant social conversation with friends and colleagues which precedes all our monthly general meetings. It was therefore decided to commence Council meetings at 3 p.m. instead of 2.30 p.m.

Since that decision, Council business has been heavy and the monthly meeting has tended to run on till well after 5 o'clock. The January meeting was no exception to this and did not conclude until about 5.15 p.m.

A great part of the time was taken up by consideration of Institute representation on outside committees. This matter has not come up for review for some time and for this reason recollection of the names of our representatives and indeed of the functions of some of the committees on which they serve, was a little vague. One of the bodies which attracted much discussion was the Parliamentary and Scientific Committee. This is a large committee numbering about 300, consisting of members of the House of Commons and House of Lords as well as representatives of scientific bodies and Institutes. Owing to the size of this Committee, it takes some time before any particular representative becomes well enough known to influence proceedings and thus some permanency of representation is desirable. We are entitled to four representatives, two who may attend the meetings and the Annual General Meeting and two who only attend the Annual General Meeting. Mr Dewhurst has been an I.P. representative for many years and will continue to serve in this capacity. Continuity is most essential in a committee of this size and for this reason Council has asked the Honorary Secretary, Mr C. Chilvers, to be the Institute's second principal representative as Honorary Secretaries usually serve the Institute in that capacity for a number of two representa- years. The other tives will be the President and Mr Tett.

The Institute has representatives on many of the B.S.I. committees and Standardization and Engineering committees have been asked to make a complete revision of the list.

The Honorary Treasurer, Mr Coxon, in the absence of Mr Hyams, presented a report of a recent meeting of the Finance Committee.

The question of restarting the Institute's Research Fund had been discussed, and it was decided to form an *ad hoc* Committee to look into the matter. This *ad hoc* Committee is to consist of the President, Mr Coxon, Professor Morton and Mr Tett.

Mr Parker presented the report of a meeting of the Public Relations Committee and recommended that an energetic effort be made to increase the membership of the Institute. It was felt that in view of the rapidly expanding

ANNUAL DINNER 1951

The Institute of Petroleum is highly honoured by the acceptance of **Vice Admiral Earl Mountbatten of Burma, K.G., P.C., G.C.S.I., G.C.I.E., G.C.V.O., K.C.B., D.S.O.** to be the chief guest and speaker at their Annual Dinner at Grosvenor House, on Tuesday, March 6, 1951.

It is hoped that the dinner will be enthusiastically supported. Tickets, price £2.2.0. each, can be obtained from the General Secretary, and it is requested that a remittance should accompany applications.

refinery operations in this country, the number of Corporate members should be materially larger.

The new Brochure will be ready for issue during the next few weeks and a copy will be sent to each member together with a letter from the President, pointing out the advantages offered by membership of the Institute and asking members to bring these to the notice of their friends and colleagues.

A number of countries overseas with a flourishing petroleum industry have not so far formed branches of the Institute. A possible explanation put forward was that in some cases these overseas staffs were employees of one company or group of companies. Since they had direct contact with their colleagues in the course of their day-to-day work, there was no incentive for them to form a branch where they could foregather for discussion.

However, there is scope for some new overseas branches and the matter will be investigated.

In order to knit together overseas members with the parent body, it has been suggested that the Institute should hold a special meeting during the summer when many of these members are home on leave. It may be difficult to do this in 1951 owing to the World Petroleum Congress, but the suggestion will be borne in mind for future years.

There are four nominations for four vacancies for Council for the 1951/1952 and it will therefore not be necessary to hold an election.

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THE I.P. ELECTRICAL CODE

The increasing use of electricity in all branches of petroleum production and distribution has led the Institute of Petroleum to prepare a code of safe practice in its use on oilfields, in refineries, and in storage installations and depots. The second edition of the Code now published has been carefully revised, and it presents the considered opinion of experts drawn from all branches of the petroleum industry. The recommendations do not supersede standards for good general electrical practice, but they extend these to the special cases which arise when petroleum or its products are handled, and to the handling of products of similar characteristics.

So that there need be no doubt as to the circumstances in which special precautions should be taken, the Code opens with carefully-worded definitions of the terms used later in its text. It then assesses and classifies the risks incident to various grades of petroleum and similar products. It points out that in general two adverse conditions must be simultaneously present before fire or explosion can occur, and it develops effective methods of prevention based on this and other considerations.

Electric power deliberately used for useful purpose has, of course, adequate attention. Apart from this, charges of static electricity may be developed in handling of petroleum; conditions which may lead to these charges are fully discussed, with in turn the good practice that best avoids their formation, and automatic and other safeguards against their possible effects.

The Code ends with a series of brief rules of good practice, arranged for the ready reference of those already familiar with the earlier text.

Copies of the Code may be obtained from the offices of the Institute, the price being 26s., post free. To facilitate revision, the Code is in loose-leaf form and the price includes a special binder designed to accommodate the other three parts of the complete code of safety practice when they are published. Members of the Institute may obtain one copy for 21s.

CONTAINERS FOR PETROLEUM PRODUCTS AND OTHER SPECIAL MATERIALS

By J. MASON M.B.E. (Fellow)

This subject is important and interesting—important because the use of unsuitable containers results in loss or damage of contents, and interesting because of the chemical and physico-chemical effects which are involved. The ideal container should be of suitable size and shape, sufficiently strong and tight, chemically inert to the intended contents, including anything present owing to solubility effects, resistant externally to weather and any solvent action of the contents on pouring out, in good condition when filled, and correctly and satisfactorily marked. This standard has not been uniformly attained in the past, and it is the object of this paper to describe some of the troubles which have been met, and to outline the efforts which have been or are being made to overcome them. The subject has been referred to previously by the author in a paper read to the Institution of Engineering Inspection on November 7 1946.*

There have been few troubles with regard to size and shape, as these points command early attention. Lack of strength has not been very troublesome except for certain trade containers for paints and the "flimsy" 4-gallon tin for petroleum products. The latter faded into the background on this account during the war, being superseded by the stronger and better jerrican. Gauges, shapes and sizes for containers are well dealt with in B.S.I. specifications.

Tightness of containers has been a considerable difficulty. It has not been generally appreciated that all small containers should be gas-tight as well as liquid-tight, whether the intended contents are volatile or not. The non-tightness has usually been due to inefficient closures. The omission of welding or soldering of seams of metal containers has contributed on occasion —with paint thinners and removers. If a container is not gas-tight, "breathing" takes place with temperature changes.

A typical case is of a container standing with the non-gastight closure at the top, inward "breathing" being of atmospheric air (probably moist), or of water if the container has a dished end which happens to contain water above the level of the closure. The mechanism and effects of "breathing" depend on the circumstances, including the type of container and closure, the contents, and how stacking has been done. Inward "breathing" will be of whatever is outside next the closure, and outward "breathing" of whatever is inside next it. With drums of oil having non-gastight closures, the effects will include ingress of moist air or water and egress of oil. All these effects are objectionable. The egress of oil may occur in two ways, (1) by floating out as water is "breathed" in from a dished end, or (2) by being forced out when the closure is below liquid level and the temperature rises, causing increase of pressure in the ullage space, and expansion.

If instead of oil the drums contain castor-base hydraulic fluid, the possibilities are analogous, with the additional point that ingress of water can completely ruin the contents by causing separation into two phases. Ingress of water by "breathing" from an accumulation in a dished end is prevented in some modern drums by an interrupted chimb. This is a good idea, but it is a pity that some drums of this type are not fitted with gas-tight closures. With gasolines,

* *J. Instn. Engng. Inspection* 1947, **3**, 7.

gas- and liquid-tightness are particularly important not only to avoid material loss but also to avoid the undesirable effects of "weathering" on quality, chiefly loss of volatility and increase in T.E.L. content (if leaded). The usual 3-pint or ½-gallon sample cans for gasolines have been unsatisfactory owing to the closures, and the same objection applies to the familiar 2-gallon can. The worst of these is the 3-pint can, the ½-gallon and 2-gallon types being rather better. The most satisfactory sample can used so far is the jerrican.

Greases may also be affected by moist air or water getting in by "breathing."

It is easily concluded that metal containers should be of adequate gauge, should have their joints all-welded or all-soldered as appropriate, and that a gas-tight closure should be provided.

In a review of the closures which have been used on small containers for liquids, the conclusions are that the most satisfactory kind has been the special type mentioned below, and the special type fitted to jerricans, and that other types have not been so successful. The ordinary screwed type, for instance, has been used on some 5-gallon drums and 3-pint and ½-gallon sample cans. It is not possible to know whether such closures are tight; they can usually be re-tightened after lapse of time, and the washers are often of unsuitable materials. Push-in closures will probably not be tight unless they are fully soldered.

A certain special type of screwed bung has been very successful, particularly when used with an overseal. With this type of screwed bung it is possible to know when it is tight, as the bung cannot then be screwed further owing to the metal-metal contact at the top, and the synthetic rubber (Perbunam) washer is in an adequate and limited state of compression. This principle also prevents the washer being damaged. This screwed bung closure is said to be as strong as the material of the drum. The overseal, with the current washer of a mixture of synthetic rubber (Perbunam) and cork, without the screwed bung, will itself withstand a pressure of more than 40 p.s.i. The extent of contact of the contents with any of the washers is small.

The washers of course must be of material resistant to the contents. The Air Ministry and the Aeronautical Inspection Directorate are about to adopt a ½-gallon sample container for aviation fuels, equipped with a ¾-inch closure of this type. Efforts were made to find suitable washers for the previous types of cans, by trying synthetic rubber alone, and reinforced by wire, but these were unsuccessful, largely because being too soft, the washers—flat discs—would not stand up to normal usage. The new ½-gallon cans, which will travel in special wooden boxes, will probably be very satisfactory. The jerrican closure has been very good in respect of tightness, but it has been reported as being rather liable to damage. For greases the best solution is likely to be the collapsible tube, which is probably gas-tight because of the nature of the tube itself. Lever-lid tins often are not gas-tight.

For a container to be satisfactory, in addition to strength and gas- and liquid-tightness, it is necessary that it shall be made of, or lined with, a material which will not react in any way with the future contents or anything present owing to solubility effects. A great deal could be said about this, as in the packing of petroleum products and other special materials, this requirement has not been fully met.

Petroleum products are frequently handled in containers made of steel. The corrosion which results from the oxygen and water which are inevitably present, owing to their being dissolved in the contents, is a very big problem. Tankers, tanks, pipelines and barrels made of steel, are subject to this attack,

and the extent of protection is usually not great. Unprotected steel barrels have been much used for aviation gasoline, but they are really unsuitable, the contents becoming contaminated with fine rust. A new bright steel barrel, correctly filled and tightly closed, will show presence of rust after three to four months.

It is likely that petroleum or other products, stored in tanks which are vented or which have pressure/vacuum valves, are saturated with water and air. It can be expected that the corrosive tendency due to this will diminish from the gasolines to the less volatile products such as lubricating oils, because the solubilities of both water and oxygen diminish in this direction. It is probable that oxygen and water are similarly soluble in many other liquids, as the property is not likely to be limited to hydrocarbons and mixtures of them. Some special products, in any case, are aqueous solutions. As these corrosion effects inside containers are hidden, it is likely that much interesting information will be obtainable from a detailed study of the contents and interiors of containers in which various products have been stored. Some of this information has been obtained already and further investigations are in progress.

The first and most prominent example of corrosion is the rusting of steel containers filled with gasoline. The rust formed, and any other solid matter which may be present, is a menace to fine clearance parts in engines, especially those in fuel control mechanisms of both piston and turbine type engines, and it is troublesome in refuelling operations with chamois leathers. The removal of these fine rust particles—many are as small as 1 micron (0.001 mm.)—can only be accomplished by very efficient filters. The best so far tested in the Aeronautical Inspection Directorate laboratories is of the finest grade of sintered bronze. Rust has been known to diminish the inhibitor content of gasoline. Occasionally there has been colour-fading of leaded gasoline in steel barrels.

Rust contamination has been troublesome more recently in de-icing fluid D.T.D.406A—an aqueous solution of ethylene glycol and ethyl alcohol.

The preliminary survey of packed stocks has shown varying degrees of corrosion in containers of identification colours, cellulose finish, de-icing fluids, alcohol, ethylene glycol, brush wash, compound degreasant liquid, anti-freezing oil, thinners, cleaning solvent, and lubricating grease. When all the necessary information on this matter is available it should be possible to arrive at valuable conclusions. It will be necessary to make allowance for possible corrosion prior to filling. It is desirable to fill steel containers as soon as possible after manufacture, as they do not store well empty, unless suitably protected. Rusting may be caused by traces of water derived from air-pressure testing under water, or by traces of soldering flux. Allowance will need to be made too for the fact that unprotected steel containers had to be used, during the war, for products for which they were not really suitable, and for which they were not previously used. The containers used for the materials mentioned above will probably be quite varied.

Experience has shown that galvanized containers are unsuitable for the storage of leaded aviation fuels. The effects which have been observed — after periods of six months or more—have included the formation of white deposits, and colour changes, and there will have been accompanying bromine loss from the gasoline due to combination of the zinc with some of the bromine of the ethylene dibromide added in the T.E.L. fluid. All these are most undesirable effects.

There are possibilities of attack of containers by organic acidity present in a product or developed on oxidation.

Castor base hydraulic fluid D.T.D.641 is found to give a high ash content when stored in certain metal containers. Oxidized M.T. gasoline will corrode copper pipes, and oxidized greases will corrode steel. There are also possibilities of attack by sulphur compounds in petroleum products.

The propensities of various products to cause or allow corrosion of containers also persist in the systems in which the products are used, e.g. fuel, coolant and hydraulic systems, and the problems which arise are analogous to those in containers. Great effort is still necessary to harmonize containers, systems and products. The operation of all of these systems is likely to be hampered by the presence of solid matter, whether adventitious or resulting from corrosion of containers or systems.

Much improvement as regards inertness to contents has been made by the use of protective coatings, and it is by this means that further improvements are most likely to be made. Containers of tinned steel have generally been very successful but troubles may occur due to porosity and corrosion promoted by flux residues. Preliminary experiments at Harefield have given good results with nickel-clad steel. Petrol-resisting paint has been used on 30 by 9 foot tanks and refuelling vehicles. The jerrican with its stoved internal coating of petrol-resisting non-flaking paint has been very successful, though the paint does not last indefinitely; with its tight closure too, the jerrican must be considered one of the most successful containers ever devised. The British wartime jerrican internal paint was tried on 40-gallon drums in a storage experiment with 100/130 grade aviation fuel lasting for two years eight months, but finally it was not considered suitable for this use. American drums for reference fuels for engine testing have been protected internally since 1943 and have been extremely good, the very thin coating having remarkable adhesion and resistance. It is a pity that all fuel drums have not been similarly coated. There is a good deal of interest in protective lacquers. At Harefield, storage tests are being arranged with a variety of products, in containers coated with various synthetic lacquers, and parallel tests will be done in bare steel drums and in current British jerricans. The chief requirements of these internal coatings are good adhesion and resistance and non-flaking property. It is a pity that such coatings are less likely to be suitable for use in aircrafts' systems. The danger of flaking in those conditions is probably too great.

While light alloys must be regarded generally as liable to corrosion, remarkably good results have sometimes been obtained. An American light alloy barrel, as used for air transport of fuel, gave remarkable results in a storage experiment over two years eight months with 100/130 grade aviation fuel. At the end the condition of the anodized interior was very good, and the contents showed only a very small amount of white solid matter. Also, a light alloy Dakota tank, some six years old, on examination recently, showed no corrosion whatever.

The paint, or whatever external protection a container has, should be weather-resisting and resistant also to the contents when they are poured out. It is inconvenient and possibly harmful if a paint not resistant to the contents is used. This has sometimes happened with castor base hydraulic fluid.

Much more could be said on this subject, but if this paper does anything to increase the general appreciation of the problems involved, the author's intentions will have been fulfilled.

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AROUND THE BRANCHES

FAWLEY, LONDON, NORTHERN, SCOTTISH, SOUTH WALES, STANLOW, TRINIDAD

London Branch

The fourth meeting of the 1950/51 session was held at Manson House on the evening of December 20 to hear J. T. Tyson, M.C., read a paper entitled "Patents and Portents," with N. E. F. Hitchcock, the Chairman of the London Branch, presiding. Dr Tyson's paper, while full of interesting information on a subject with which most people are completely unfamiliar, succeeded in being at the same time witty and entertaining. After describing the origin and development of the patent as a legal concept, the lecturer went on to explain the situation today and the manner of getting patent protection. The use of patents in the petroleum and allied industries was dwelt on in some detail and the lecturer finally made the point that patents, while protecting the ideas of inventors, also form a permanent record, unique in its scope, of technological developments through the years. Dr Tyson's paper was illustrated by many examples—often strange and highly amusing—as well as by slides, and was deservedly well received.

After a brisk discussion ranging over a wide field of topics connected with the paper, a vote of thanks proposed by R. A. Fraser was carried with enthusiasm. Thereafter discussion continued when the lecturer was entertained to dinner by representatives of the Branch.

Scottish Branch

At the meeting held on Thursday, January 11, an address was given by A. W. Jarman, of Scottish Oils and Shell-Mex Ltd., London, on "Bitumen Horizons." Mr Robert Crichton, J.P., was in the chair.

The speaker said that although bitumen was a recognized derivative of petroleum, and its use for roads and buildings went back to Babylonian times, its many present-day applications were not always appreciated even by petroleum technologists and the primary object of the paper was to survey current British practice in regard to its utilization. Complementary to this, and with the aim of stimulating discussion in technical circles, the properties of bitumen had been critically reviewed to examine the possibilities of extending its scope still further by modifying some of the inherent characteristics.

The controversial subject of terminology was ventilated, as although the existing definitions for bitumen and asphaltic bitumen might be well-founded scientifically they were difficult for the average user to comprehend and were not in accord with the conventional meaning attached to the term "bitumen" There would seem, the author considered, to be some justification for simplifying the definition in the direction of common usage of the word.

The uses of bitumen were arbitrarily classified under the headings of road surfacing, airfield surfacing, hydraulic engineering and industrial uses.

Mr Jarman said the "industrial" uses of bitumen covered an extremely wide range, rather difficult to classify systematically and therefore treated in alphabetical order, with brief references to the processes and principles involved.

Some indication of the extent to which these uses of bitumen entered into the daily life of the community was given in the following passage from the author's introductory remarks to his paper.

"The layman may not have much occasion to extend his knowledge of bitumen as such but finds it difficult to escape its influence. His house may have an asphalt

or bitumenized felt roof or dampcourse; his floor covering may have a bitumenized felt base; his water and electricity mains may be protected with bitumen. His car may be lined with bitumenized panel board; its battery cased in a bituminous moulding compound and sealed with bitumen; its tyres and brake linings may contain bitumen; it runs almost inevitably on bitumen-bound roads. His shoes may be stiffened with bitumenized board; his refrigerator may have a bitumen adhesive; his radio set probably contains bitumen for insulation. His garden shed may be preserved with bitumen paint; the bristles of his domestic brushes may be held in place with bitumen; bitumen may be keeping moisture out of some of the cartons in his larder; it may have lined the barrel from which his beer is drawn. The magazine he reads in the evening may be printed with bituminous ink; the lenses of his spectacles may have been bedded in bitumen for grinding. Even at the end of his earthly span the utility of bitumen may still pursue him as the lining of the coffin in which his mortal remains are encased."

The speaker's examination of the properties of bitumen included its adhesion characteristics, and devices for their modification; its general physical properties; its chemical properties, as affecting weathering and thermal stability and a brief reference to colour.

The presentation of the paper included a showing of the film "Asphaltic Bitumen," which illustrated many of the points discussed.

Stanlow Branch

A highly interesting talk was given on November 30 at the Public Library, Chester, by L. Massey of Metropolitan Vickers on laboratory tests in relation to the selection and performance of transformer oil, and materials used in the construction of transformers.

As an introduction, reasons were given why transformer oil, in addition to being most economical, was a suitable choice for use in transformers.

The deterioration of oils in service was dealt with. Causes of deterioration were described, moisture being shown to be the worst factor. Ways and means of keeping down deterioration were discussed in relation to oil and construction materials.

Selection of materials and suitability of oils were investigated in exhaustive laboratory tests based on the B.S.S. 148/1933 sludge test and on long-term ageing tests. Results were graphically illustrated on slides, and were very comprehensive, covering a long period of research.

The use of inhibitors was mentioned as a recent important development. The importance of selection of materials of construction was stressed.

A lively discussion followed the paper, to which several visitors contributed.

South Wales Branch

The fourth meeting of the 1950/51 session was held on Thursday, December 7, when a talk was given by J. J. Darley, of the Anglo-Iranian Oil Co. Ltd. on the subject of "General problems at Abadan refinery." The talk was illustrated by many lantern slides.

Mr Darley covered the ground from the pioneer days in Persia to the present, giving a very lucid account of the problems involved and how they were overcome and implemented.

The points covered were: recruiting and training of labour, housing for European staff, transport facilities, food problems and development of farming activities, household stores and grocery supplies for employees, schools and technical institutes. In fact, he dealt with all services necessary for what one might describe as a "small township." The talk was illustrated by unusual lantern slides and was listened to with great interest by one of the biggest audiences the Branch has had for some time. The talk was of particular interest to trainees and students employed by the National Oil Refineries Limited, who are likely, at some time in the future, to be transferred for service at Abadan.

The meeting concluded with a vote of thanks, proposed by F. V. M. Bell and seconded by A. C. Blackall.

PERSONAL NOTES

R. A. Hyslop was recently presented with a fourth diamond for his six pointed service star to mark the completion of 40 years' service with the Anglo-American Oil Company. Mr Hyslop joined the company as a junior clerk at the age of 14 and is now assistant general sales manager.

H. K. Stein, secretary and law officer of Shell-Mex and B.P. retired at the end of 1950 after 30 years' service with the company and its predecessors.

A. J. Foster, M.Inst.Pet., has been appointed general supplies manager of Shell-Mex and B.P. Ltd. He will be concerned generally with supplies of products for the company and their quality, and for purchases of services, stores, and equipment. The company's purchasing, supplies and transportation, and technical departments will come under his control.

W. A. Woodrow, F.Inst.Pet., sails this month on the *Orontes* for Perth, Western Australia on a family visit. He intends to remain away from England for a year.

Charles R. Nelson (manager of Process Engineering Dept of Shell Development Co. Emeryville), and **R. C. Gunness** (manager of research, Standard Oil Co. (Indiana) are two of the four new directors for 1951 of the American Institute of Chemical Engineers.

V. St. J. G. Van der Byl has been appointed joint aviation manager of Shell-Mex and B.P. Ltd.

Desmond Abel Smith, M.C., has been appointed to the Board of the Anglo-Iranian Oil Co.

Captain Griffith Allen Thomas has retired after more than 30 years' service with the Shell tanker fleet. During his career he served in 24 ships, and commanded nine of them. He will in future live in South Africa.

P. Low, M.Inst.Pet., was awarded the M.B.E. in the New Year's Honours. He is superintendent of Anglo-American's Purfleet installation.

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STANDARD FORM FOR ABSORPTION SPECTRA

The Chemical Research Laboratory has designed a blank printed form for the plotting of infra-red absorption spectra. The size of the form is $10\frac{1}{2} \times 8\frac{1}{2}$ inches, and it allows percent absorption to be plotted as ordinate against the wave number on a linear scale which extends from 400 to 5000 cm^{-1}. Intercomparison of spectra by superposition is facilitated by the choice of a paper which, besides being semi-transparent, changes only slightly in dimensions at varying humidities.

A transparent scale which can be moved along the printed grating to sub-divide the percent absorption and wave number scales is available.

Pads of 100 forms at a cost of 6s per pad and transparent scales at a cost of 4s each may be obtained from the Director, Chemical Research Laboratory, Teddington, Middlesex.

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Eurotank Refinery. In the account of the opening of the refinery (*I.P. Review*, November 1950) the names of the Llandarcy representatives were incorrectly given. They were in fact Messrs W. John and T. Monger.

I.P.-A.S.T.M. CO-OPERATION

Mr C. G. A. Rosen, of the Caterpillar Tractor Co., Peoria, Illinois, U.S.A., arrived in England in November, at the invitation of the Institution of Mechanical Engineers, to deliver a Clayton Lecture to the Automobile Division. The A.S.T.M. took advantage of this visit of one of its distinguished members, by asking him to convey a message to the Institute of Petroleum. A special meeting of the Standardization Committee was held on 6th December, 1950, when Mr E. A. Evans, Chairman, accorded Mr Rosen a very hearty welcome and apologized for the unavoidable absence of the President, Mr C. A. P. Southwell.

Mr Rosen stated that he had been entrusted to say how much the A.S.T.M. valued the friendship and co-operation of the Institute of Petroleum, and hoped than an even closer relationship would ensue. The visit of Mr Evans, when he was President of the Institute in 1949, had done much to cement the friendship, as did the recent visit of Mr Hyams to A.S.T.M. Committee D.2. In the interests of the petroleum industry wherever it might be, and of the users of petroleum products, it was essential that standard methods of test should be available. To this end much had been done individually and collectively by the A.S.T.M. and the I.P. The A.S.T.M. wished it to be known that it was prepared to do everything within its power to have agreed methods with the I.P. He therefore hoped that the co-ordination of tests which was well advanced would be speeded up and others brought rapidly under review. Perhaps exchange of visits could be arranged.

Owing to the size of the organization of the A.S.T.M. he felt that its procedure was probably slower than in the I.P. Therefore it was comforting to know that the C.R.C. was anxious not only to co-operate with the I.P. but to consider the possibility of having an I.P. representative on its Council. He explained that the C.R.C. organization is a research group and does not prescribe methods of test or prepare specifications but does lend assistance to bodies such as A.S.T.M. who do this work. The assignment group represents the interested industry and assigns new projects.

Mr Rosen outlined various ways in which C.R.C.-I.P. collaboration would, he believed, be welcomed by C.R.C. He also referred to the desire of the U.S. Services to develop common specifications and test methods with the British services. He concluded his remarks with an appreciation of the work of the Standardization Committee.

Mr Evans thanked Mr Rosen for his very encouraging message and for the assurance that the work of the I.P. had received worthy recognition in the U.S.A. The I.P. would enter with enthusiasm any co-operative scheme which could be formulated.

Mr Hyams supported the vote of thanks.

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LIQUID FUELS COURSE

A course of six weekly lectures of liquid fuels, their properties and utilization, began this month at the Northampton Polytechnic. The course is given by G. F. Murray and lectures take place on Tuesday evenings at 7 p.m., the final one being scheduled for March 13. Further details are available from Dr J. E. Garside, Northampton Polytechnic, St. John Street, London, E.C.1.

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Kuwait. Production of crude oil in Kuwait for the month of November 1950 amounted to 1,608,053 tons.

PERMUTATIONS AND COMBINATIONS

By A. F. DABELL (Fellow)

"As truth is to the part—the remainder is to the whole"

It was during the first world war, when Germany, in dire need of oil, moved troops in the direction of Rumania. South of the Danube the Bulgarians were similarly active.

In due appreciation of the position, the British Government appealed to that of Rumania to organize a scheme for the destruction of the oilfields, refinery stocks and equipment throughout the country since their acquisition as a going concern would represent an asset of immediate and incalculable value to the enemy.

In support of such a policy, the British Government gave an undertaking, equally subscribed by France and Russia, to indemnify Rumania for the losses occasioned by the adoption of so radical a policy.

To stress the importance and urgency of the appeal, the late Sir John Norton Griffiths was sent to Rumania.

On his arrival, he found the Rumanian Government, buoyed up with the hope of beating back the enemy advance, understandably averse to sanction the adoption of the Allied plan.

With characteristic energy, Sir John determined to make a start on his own.

Although possessing no technical oilfield knowledge, Sir John—known to his friends as Empire Jack, by casual acquaintances as a madman and later, by a Judge of the High Court as one emulating the God Thor—by value of his dynamic and resolute character was the ideal man for such an enterprise.

He was courageously supported in his decision by a small body of able men who contributed an intimate knowledge of the language, the country, and the industry generally. Amongst these T. S. Masterson and J. T. Hayward played a notable part.

However, as it soon became evident to the Rumanian Government that invasion was imminent and inevitable, official sanction was given to the policy of destruction and thereafter the initial efforts of Sir John and his fellow workers were greatly reinforced by the Rumanian military and field engineers themselves.

And so, with the invading forces close on their heels the agents of destruction laid waste the oil industry of Rumania.

Retreating southward, wells were plugged, stores thrown open for local looting, surface structures burned, boilers fired dry, pipelines severed and their terminals concealed and finally, stocks of oil drained to open ground where the released vapour quickly ignited.

These operations closely preceded the retarded van of the German army, now advancing through a pall of smoke, until culminating efforts were devoted to the refineries and storage stations in the vicinity of Ploesti.

Some three years later the British Government, mindful of its obligations, sent to Rumania an Anglo-French Petroleum Commission charged with the duty of assessing the damage suffered by the oil industry as a result of the action referred to.

Presumably, in recognition of service rendered, Sir John Norton Griffiths was originally nominated as Chairman, a post calling for the exercise of patience and tact, hardly the attributes of Sir John. This, it is to be assumed, he appreciated, for his resignation quickly followed.

He was succeeded by Mr (now Sir) Arthur Hearn who had been long associated with various aspects of naval oil policy, was a student of foreign languages and endowed with patience, tact and charm of manner.

France nominated a representative, whose functions were, however, confined

to matters of policy, and not to the active work of assessment.

Russia, by this time under Communist rule, denied responsibility for all preceding national obligations.

It was not possible for the Commission to get down at once to a detailed and exhaustive study of the case for the claimants as the Rumanian Government, not unnaturally, insisted on full representation in the enquiries and it took a considerable time before an eventual "Commission Mixte" was established and a number of qualified representatives selected.

From this body evolved an elaborate "Questionnaire" which, circulated throughout the industry, met with enthusiastic response accompanied by voluminous schedules.

It was then that the writer joined the British staff as technical adviser.

Casual study of claims tended to indicate exaggerated success of Sir John and his colleagues over a too widely-spread area and varying values claimed for identical units.

It is to be remembered that the destruction had taken place years before: the Germans had been in occupation and busy with re-establishment for two years, and on many occasions were associated with the differentiation of responsibility, to the end that the range of problems presented were often wide and puzzling.

However, visits to the fields showed that, notwithstanding the lapse of time there was much positive evidence of destruction clearly in view.

It was decided therefore to record in simple form the degree of destruction of units irrefutably in evidence, a decision which was to provide eventually the elements for the whole (material) assessment.

By prearrangement we would be met by the field engineer of the claimant who would conduct us to a site where for instance might be seen the casing head of a certain well—below ground-level and choked with debris to the mouth; four charred derrick leg stumps; tangled draw-works parts with bent 8-inch shafting and fractured motor lugs (only) firmly bolted to a substantial concrete foundation.

In such a case, and all similar, 100 per cent loss under each heading was promptly conceded.

The same would apply to a storage reservoir with crumpled walls; rusted boiler shells with collapsed furnace tubes; traces of building foundations with measurements according with those of a claim for a store building. (Stores proper were dealt with at a later stage.)

When appropriate—*deblayage* (cost of clearance) was added.

Sometimes we would visit a property for which full claim under all headings had been lodged and find, for instance, a well casing-head in such state that nothing could have been inserted; no trace of draw-works or charred timber in evidence, and even loose nuts on foundation bolts indicating leisured removal of plant. Vacant seatings indicated removal of boilers and rivet heads on a reservoir site showed that a tank had been removed plate by plate, etc.

The worst case of this nature applied to a remote field, accessible only in dry weather, for which total loss of all plant was claimed.

We found all derricks standing and no trace of destruction; neither did the smiling engineer maintain there had been any. (At a later date he told my assistant that his employers never expected our visit.)

Justice calls for acknowledgment that in no case had a field engineer attempted to uphold a false claim nor refused to agree with any degree of depreciation we recorded.

Upon completion of field work the Ministry of Mines was approached with a view to determining the monetary value of those units which we had

assessed in terms of percentage depreciation only. They were generally of standard type; motors of 45, 60, and 75 h.p.; derricks of standard heights; draw-works of 4, 6, or 8-inch shafts, etc. The Ministry presented us with a schedule of prices based apparently upon current U.S. quotations, and applied even to derrick timber from New Orleans, though appropriate timber was obtainable from local saw-mills.

Operations for the final stage of assembling the material collected, were then transferred to an office in Westminster.

Here, closer study of the schedule revealed that the prices given carried the suggestion that they included a margin for anticipated reduction by protracted bargaining on lines peculiar to semi-oriental States.

The consistent nature of this margin permitted the application of a corrective factor to all items, to the end that reasonable base-prices were established.

Transposing percentages to francs was then merely a matter of routine.

There now remained for assessment those items not included in the schedule of prices and of which no trace remained *in situ*.

A typical example under this heading lay in the contents of field stores.

On the assumption that, for instance, the degree of exaggeration shown by the proven would apply equally to the unproven; comparison was now made between the assessment established and that of the claim made.

The factor thus obtained was then applied for incremental and decremental correction of the unproven fraction of each claim.

(As the bulk of the claims appeared to have been drafted in a spirit of exaggerated optimism it would not be unreasonable to describe it as a factor of exaggeration.)

A few, however, through ignorance or unerring foresight of eventual government method of distribution, were of casual nature, calling for awards in excess of claims lodged.

The final figures were then included in a cohesive whole by the presidential master hand.

Looking back on the work done by the Anglo-French Commission it can fairly be claimed that it dealt with problems in a spirit of equity; that it established good relations both individually and through the medium of the Commission Mixte with its Rumanian colleagues, and that it presented the Government departments concerned with adequate data for arriving at a final decision on certain major questions of policy which lay outside the competence of the Commission.

The Order of Chevalier de la Couronne du Rumanie was conferred on the writer.

Addenda. The author of a book reviewing the history of German infiltration into the Balkan States prior to the second world war writes that had the Allies destroyed the oil wells of Rumania prior to the entry of the Germans "the action might have changed the course of the war and perhaps decided its issue."

Our study of the effect of destructive efforts tended to indicate that a live oilfield cannot be killed.

Viewed technically, the plugging of wells was generally effected by lifting the tools standing in the derrick into the well mouth; blocking up the brake handle and running to escape the lash of the wire rope as it tore from the winding drum. Hand-tools and fractured parts of cast iron motor bodies, etc., were added until in most cases wells were filled to the surface when casing clamps were released and derricks and sheds fired. Though the wells were plugged and destroyed by experts, when German technicians arrived many wells were overflowing. Some that were plugged hermetically, under cumulative pressure had ejected volcanically their entire contents.

One well at Moreni that had been twice drilled into oil under exceptionally high pressure but which had yielded only sporadic destructive discharges defying control, was presumably afforded the critical degree of "choke" by the plugging material, for it flowed steadily during the whole period of German occupation.

It was consequently merely a matter of hours for a German chemist with a few pipe-fitters to adapt steam boilers with collapsed furnace crowns to stills, and from the crude available vaporize and condense the lighter fractions required for local development.

From the records left by the Germans, it was to be seen that operations for clearing the most promising wells were quickly put into effect.

For this purpose the Rumanian drillers, many of whom had assisted in the original plugging of wells—under German direction worked equally assiduously in clearing them. The Rumanian is a skilled "fisherman."

Some wells were cleared in a few days by the simple withdrawal of the whole column of casing with all that it held.

We saw single detached joints of casing filled with debris obviously so tightly tamped as to defy clearance even at the surface.

By the transfer of machinery from outlying districts and the importation from Germany of duplicates of that destroyed, mostly of German origin, but a short time elapsed before shipment of oil was made to Germany by rail and river.

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FINNART PIPELINE

A 54-mile arc-welded pipeline extending from Grangemouth, on the east coast of Scotland to Loch Long on the west coast, is now being constructed for the Anglo-Iranian Oil Co.

The pipe, which is 12 inches diameter and of $\frac{3}{8}$-inch wall thickness, is delivered in 35 ft lengths with the ends ready prepared. Quasi-Arc pipe welding electrodes are then used for butt welding lengths of pipe together. After approximately a mile of pipe has been welded the ends are blanked off and tested under a pressure of 100 p.s.i. Finally, each joint is painted with bitumen paint and a mild steel mould is clamped round it.

A Caterpillar tractor lowers the finished pipe into the trench.

A member of the welding squad at work.

COAL HYDROGENATION

The U.S. Bureau of Mines, in a paper read at the December 1950 meeting of the American Institute of Chemical Engineers, by E. L. Clark and others, of the Pittsburgh, Pennsylvania, station of the Bureau, issued a progress report on the liquid-phase hydrogenation of coal. Improvements in the process have made it possible to produce a usable fuel oil at 1,500 lb pressure, representing a three- to six-fold reduction from previously developed high-pressure processes. The lower pressure permits the use of welded equipment and more available piping materials instead of the heavy forgings and special piping and valves required for the existing high-pressure process. Such simplification in process equipment may make it feasible, according to Clark, to produce fuel oil locally in regions where petroleum is scarce, but where coal is plentiful. This would relieve the stress on U.S. and Allied merchant shipping in time of emergency, as well as providing a supply of oil during normal times for those localities.

PETROLEUM IN PARLIAMENT

Branded Petrol

Asked on December 11 when branded petrol would be reintroduced, the Minister of Fuel and Power said: The sale of petrol under brand names, and of the higher octane petrols associated with many brand names, will be allowed when it can be done without reducing the total supply of petrol. I cannot yet say when this will be, but I am keeping the question under review.

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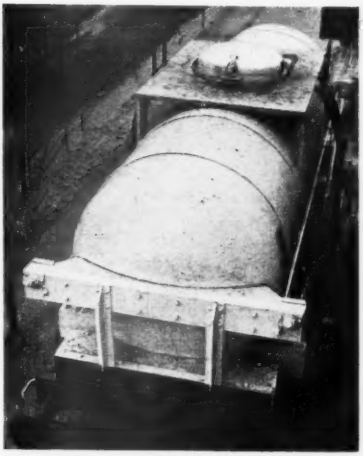
Lummus Heat Exchangers. By a recently-concluded agreement between the Lummus Company of New York and Whessoe Ltd. of Darlington, heat exchangers conforming to Lummus designs and thermal ratings are to be manufactured under licence at Darlington by Whessoe Ltd.

RAIL TANK WAGONS FOR ETHYLENE OXIDE



(British Railways photo)

British Railways (London Midland Region) in co-operation with Petrochemicals Ltd. have built ten specialized rail tank cars for the conveyance of ethylene oxide in liquid form, under pressure, between Partington and various Continental destinations via the Harwich-Zeebrugge train ferry service.

The tank cars have been constructed to accord with Home Office and Continental requirements. The plates are welded, each plate having been subject to X-ray examination at all stages of manufacture. The capacity of each tank is 7½ tons net liquefied gas.

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SHELL BOOKLETS

Booklets recently issued by Shell Petroleum Co. Ltd., concern chemical solvents and cutting oils. The former gives details of the properties and uses of various ketones, alcohols, and ethers, while the latter is devoted to various aspects of the selection, the testing, and the use of cutting oils.

FIRST OIL FROM "TAPLINE" REACHES BRITAIN

The first consignments of Arabian crude oil to reach the United Kingdom from the Trans-Arabian Pipe Line Company's great new pipeline which stretches for over one thousand miles across the Arabian Desert, linking the Persian Gulf with the Mediterranean, arrived at Anglo-American's Fawley refinery last month.

"Tapline," has its beginning in the Abquaiq oil field of Saudi Arabia. A line to the Arabian-American Oil Company's (Aramco's) refinery at Ras Tanura branches off the main line from Abquaiq and from this juncture the main line extends 1067 miles across the desert until it reaches a point four miles south of the port of Sidon, in the Lebanon. Until three years ago no vehicle had ever travelled the entire route.

Built at a cost of two hundred million dollars, this pipeline will make available large quantities of crude oil on the eastern shore of the Mediterranean. A fleet of 65 tankers will be saved, and the 3500 miles haul around the Arabian peninsula, up the Red Sea and through the Suez Canal, will be obviated.

Present capacity of the pipeline is 300,000 b.d. The annual throughput will reach a 110 million barrels, approximately fifteen million tons,

Taking almost three years to construct, this line was completed in November, 1950.

Much planning and preparation preceded the actual construction. Groups of engineers spent many months surveying the proposed route. As economy in shipping space was essential, it was decided that the pipe should be made in two sizes, 30 and 31 inches in diameter, in order that the smaller pipe could "nest" inside the larger.

A new port, Ras el Misha'ab, had to be constructed on the Persian Gulf to receive the cargoes of pipe, the first of which arrived on December 20, 1947. No drinkable water was available at this new town and a plant for the distillation of sea-water was installed. Roads had to be built across the desert, airfields constructed, wireless links established and deep wells sunk to ensure a reliable water supply. New communities had to be built at each of the six booster pumping stations, a hundred and fifty miles apart—small towns, complete with mosques, schools, shops, laundries, and hospitals.

The pipeline itself crosses moving sand dunes, old lava beds, and two ranges of mountains in the Levant. Some sections are buried and others, where the land is rocky, lie on the surface. Special lorries and trailers had to be designed to carry the pipe line across the desert.

Towards the middle of 1950, oil began to flow through the pipeline and it took almost five million barrels of oil to fill it. On December 2, the pipeline and the storage tanks at Sidon were full and "Tapline" was officially opened.

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"MECHANIZED FARMING"

Towards the end of 1948 the first edition of this book was published by the Anglo-American Oil Co. Ltd. A second edition, considerably enlarged (from 128 to 160 pages), with five new chapters, and much new information is now available. It follows the lines of the previous edition in dealing with the mechanical implements available to the farmer, the fuels and lubricants for use in those machines, and their care and maintenance. Price is 8s 6d, and copies are obtainable from 36 Queen Anne's Gate, London, S.W.1.

H. H. WHEATLEY, C.B.E., M.C.

The petroleum industry in Great Britain sustained a regrettable loss by the sudden death, in the early hours of December 10, of Henry Harold Wheatley, who for the last thirteen years had held a high position in the management of the Iraq Petroleum Company. In this capacity he enjoyed the friendship and the esteem, not only of many colleagues and friends in his own group of companies, but of many others both at home and abroad. He had those gifts of character which brought to him a conspicuous measure of the affection and esteem of personalities of every level and nationality with whom he came in contact.

Born in 1893, H. H. Wheatley distinguished himself in the war of 1914-18 as a Sapper Staff Officer, won the M.C. for conspicuous gallantry under fire, and attained the rank of Major. After the war he took employment with British Thomson-Houston, but early in 1920 he was invited to accept work in Iraq, and was posted to the newly-formed Ministry of Communications and Works, first as assistant and later as successor to Major-General Sir E. Atkinson.

Retiring from the service of the Iraq Government in 1937, he joined the Iraq Petroleum Company on January 1, 1938, as deputy to the then managing director, J. Skliros. He soon attained a key position in the company's affairs, conducting or playing a prominent part in many of the most delicate negotiations of the war and postwar years.

An exceptional lawn-tennis player, fine shot and admirable cricketer in earlier life, Wheatley had lately concentrated on golf and achieved, without difficulty, a single figure handicap in his club at Eastbourne of which he was Captain-elect. He leaves a widow and two daughters to whom the deepest sympathy of his and their many friends will be offered.

ENGINEERING MODELS

An exhibition of models and photographs of work being carried out by the company in many parts of the world was recently shown by Messrs Matthew Hall & Co. Ltd. at the Dorchester Hotel, London.

Of particular interest was the model of a 32,000 k.W. English Electric turbo-alternator, two of which are being installed in the new power station at Abadan.

A welding exhibit included specimens of different materials—stainless steel, aluminium, polythene, etc. Among the photographs was a series on Kuwait, showing the laying of oil pipelines across the desert, and views of the new oil town of Ahmadi, which has been completely air-conditioned from a large central refrigeration plant.

There were pictures of the cat cracker at Abadan, for which Messrs Matthew Hall supplied a gang of welders and pipe-fitters, and of a Shell refinery, where 500 men carried out the welding of the offsite facilities.

Among the large number of people who attended a cocktail party given in connexion with the exhibition were Mr C. A. P. Southwell, M.C., President of the Institute, and D. A. Hough, the General Secretary. Institute members present included Messrs S. W. Adey, A. H. T. Chisholm, G. Elias, A. E. Gunther, A. C. Hartley, J. E. Jenkin, E. C. Masterson, and D. G. Pull.

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Mobile Factory. A souvenir book, whose many coloured illustrations tell the story of the transport of a drum-making factory from Amsterdam to the 1950 Foire de Paris, has been produced by Metal Containers, 17 Waterloo Place, London, S.W.1.

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

Petroleum Waxes. T. C. G. Thorpe. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), February 14.

Fawley Branch

Oil from the Desert. C. A. P. Southwell, M.C., At Esso Recreation Club, Holbury, Southampton, 7.30 p.m., February 15.

British Car Engine Design and Performance. A. W. Becke. At Esso Recreation Club, Holbury, Southampton, 7.30 p.m., March 14.

London Branch

Petroleum in Industry, IV—Textiles. F. McLaren. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), February 21.

Planning a Large-Scale Production Operation under Desert Conditions. C. A. P. Southwell, M.C., At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), March 20.

Northern Branch

The Background of Performance Testing of Lubricants. A. Prizeman. At Engineers' Club, Albert Square, Manchester, 6.30 p.m., February 20.

Marine Lubrication. Dr Preston. At Engineers' Club, Albert Square, Manchester, 6.30 p.m., March 20.

South Wales Branch

Annual General Meeting. At Britannic House, Llandarcy, 5.30 p.m., February 6.

Accountancy in Petroleum Refining. A Symposium. C. A. Simpson and others. At Britannic House, Llandarcy, 5.30 p.m., March 8.

Stanlow Branch

Influence of Fuel Characteristics on Behaviour of Compression Ignition Engines. C. D. Brewer and B. H. Thorp. At Grosvenor Hotel, Chester, 7 p.m., February 14.

Origin and Migration of Petroleum. F. Morton. At Grosvenor Hotel, Chester, 7.15 p.m., March 21.

OTHER SOCIETIES

The Aviation Engine. Air Commodore F. R. Banks, C.B., O.B.E. Institution of Mechanical Engineers. At Storey's Gate, St. James', London, S.W.1, 5.30 p.m., February 15.

Possible Applications of Gas Turbines in the Chemical Industry. I. Lubbock. Society of Chemical Industry, Chemical Engineering Group. At Burlington House, London, W.1, 5.30 p.m., March 13.

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I.P. MARCH MEETING

Owing to unforeseen circumstances Mr van Hoogstraten will be unable to deliver the paper on Diesel Engines scheduled for March 7 at Manson House. Alternative arrangements are being made for that evening's meeting and individual notification of the programme will be sent to members.

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WORLD PETROLEUM CONGRESS

The Organizing Committee of the Third World Petroleum Congress, to be held at The Hague/Scheveningen, Holland, from May 28 to June 6, 1951, announces that it expects to publish in the course of March full details of the papers submitted. All members of the Congress will receive their preprints at the latest in the beginning of April.

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APPOINTMENT VACANT

Large petroleum organization has vacancy in London for suitable person (male or female) of sound education to take charge of centralized petroleum technical files. Age 25-35. Previous experience in office routine and in handling scientific or technical correspondence essential. Commencing salary according to age and experience. Pension Fund benefits. Five-day week. Write giving full particulars of education, experience, etc., to Box Z.L. 335 Deacon's Advertising, 36 Leadenhall Street, E.C.3.

OIL EQUIPMENT FOR EXPORT

In its December 1950/January 1951 issue, *Future* includes an interesting article under the above title. It points out how Britain has become second only to the U.S.A. as a supplier of oil-field and refinery equipments. Britain's exports of this class of material rose in value from £46 million in 1947 to £80 million in 1949, and nearly 70 per cent of oil equipment in the Middle East is of British origin.

In regard to the £95 million to be spent on new refineries in Britain, it is stated that nearly £35 million will go on equipment over five years. The estimated breakdown of this (in £ million) is given as: towers and vessels, 6.3; heat exchangers, 5.3; valves, 3.5; structural steel, 2.1; pipes, 6.3; pumps, 1.5; motor turbines, 1; compressors, 1.7; firebricks, 1.2; instruments. switchgear, etc., 5.2.

SAFETY RULES

Supplement No 1 has been published to the third edition (1947) of *Safety Rules for Use in Chemical Works, Part* 1. It contains changes made necessary by the Factories Act of 1945.

Copies of the supplement are being sent gratis to purchasers of the original edition by the publishers, the Association of British Chemical Manufacturers, 166 Piccadilly, London. W.1.

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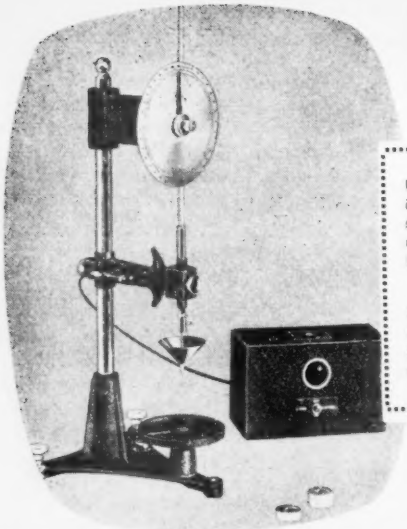

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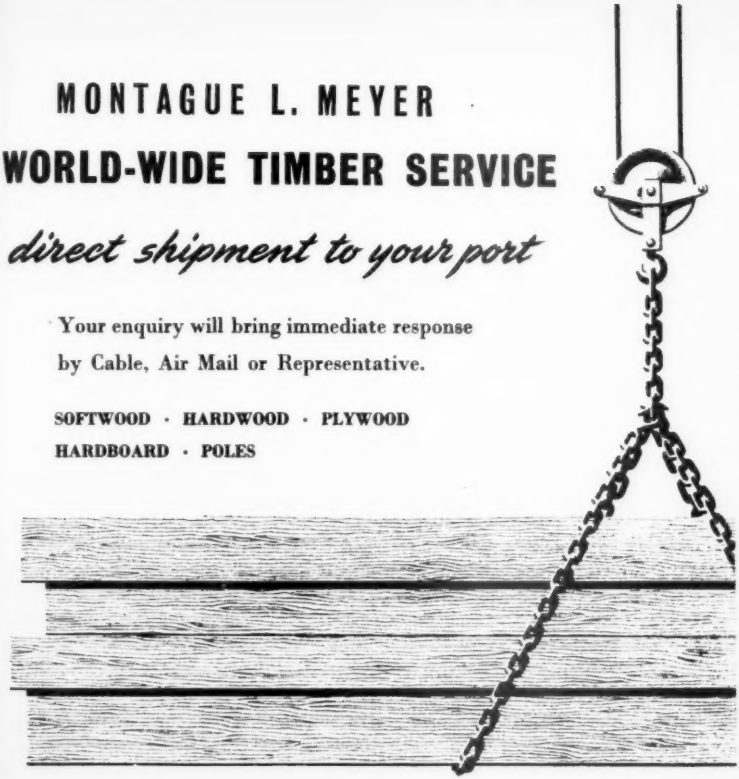

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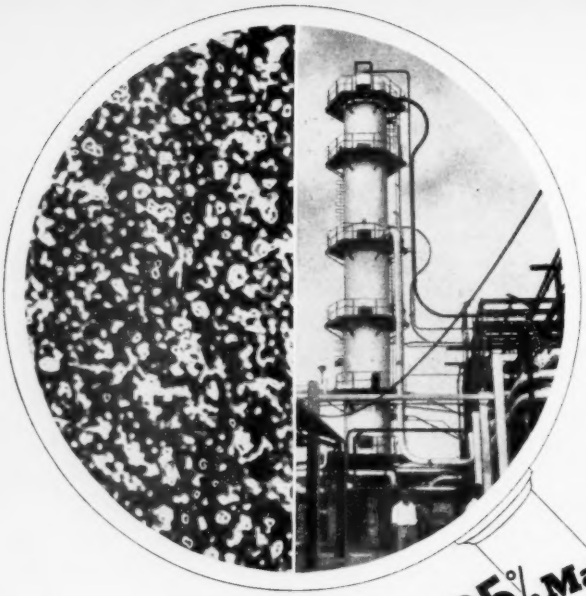

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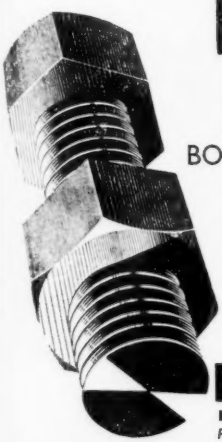

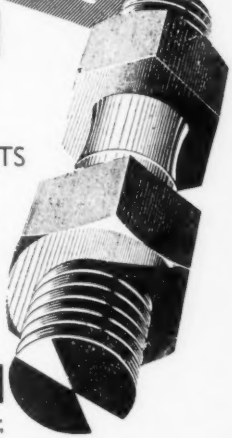

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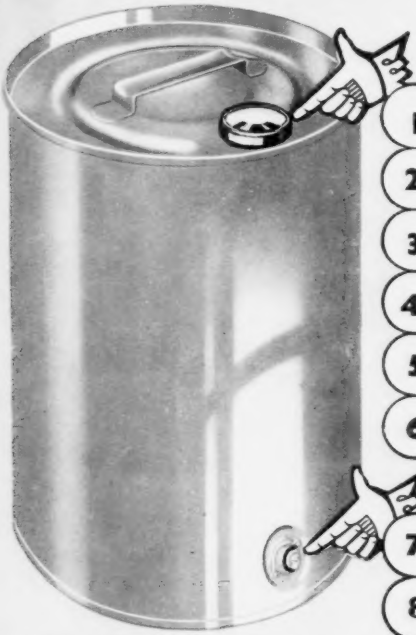

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